

PATENT APPLICATION SERIAL NO. \_\_\_\_\_

U.S. DEPARTMENT OF COMMERCE  
PATENT AND TRADEMARK OFFICE  
FEE RECORD SHEET

05/31/2006 ABRAHAM1 00000036 09866400

01 FC:201	355.00	OP
02 FC:203	72.00	OP
03 FC:202	40.00	OP

ATTORNEY DOCKET NO: 70179

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant : CANNON  
Serial No :  
Confirm. No :  
Filed :  
For : APPARATUS AND METHOD...  
Art Unit : 2877  
Examiner : Pham, H.  
Dated : May 25, 2001

Hon. Commissioner of Patents  
and Trademarks  
Washington, D.C. 20231

REQUEST FOR RECONSIDERATION

The specification and claims in this continuation application have been written to incorporate the changes made in the parent application, to address the rejections made in the last Office Action in the parent application, and to further highlight and more clearly point out the important features of the invention.

Claims 1-23 have been rejected in the parent application as being obvious over Czarnek in view of Hayes.

Applicant has reviewed both Czarnek and Hayes, and finds the present invention to set forth a combination of features which is unique and non-obvious in view of Czarnek and Hayes.

In the present invention, the light is emitted from the head 2 at an axial or longitudinal position that is the same as the axial portion of the prism or mirror 9. This relative positioning of the light and the prism is shown in Figure 2 of the present application. The light is emitted

from light exits 15, 16 and the axial direction is vertical in Figure 2. Applicant does not find any teaching or suggestion of this position relationship between a light and a reflector in the prior art. The rejection equates elements 44 and 31 of Czarnek with the illuminating device of the present invention. Applicant notes that element 31 in Czarnek is clearly axially spaced from element 27 which the rejection equates with the deviation device of the present invention. Therefore the relationship of the illuminating device being at the same axial or longitudinal position as the deviating device, is not taught by Czarnek.

Furthermore Applicant notes that Czarnek describes two mirrors 27 and 28 and specifically shows a prism 31 to project light through illuminating window 16. Element 31 is specifically taught as being positioned between mirrors 27 and 28. Applicant notes that if the primary and main purpose of Czarnek is to provide two observation windows, there would be no incentive in the prior art which would lead a person of ordinary skill in the art to move element 31 to a same axial or longitudinal position as mirror 27. Such a positioning of element 31 would be disadvantageous in Czarnek, and therefore Czarnek would lead a person of ordinary skill away from such a relative position between an image illuminating device and an image deviating device.

The reference of Hayes also does not teach nor suggest Applicant's relative positioning of an image deviating device and an illuminating device. Applicant notes that Hayes describes a light source including a housing 12 and bulb 12A. Hayes also describes a prism 14. It is quite clear from Figures 2 and 3 of Hayes, that light source 12 and lightbulb 12A are not positioned at a same longitudinal or axial position. Therefore the positioning of the illuminating device and

the deviating device being at the same axial position is also not taught in Hayes. Furthermore Applicant finds no incentive which would lead a person of ordinary skill in the art to place the illuminating source 12 or the lightbulb 12A of Hayes at a same axial or longitudinal position.

The combination of Czarnek and Hayes therefore fails to describe all the features set forth in the independent claims. Furthermore, Applicant finds no incentive in the prior art which would lead a person to the relative positioning of the present invention. Therefore the combination of the prior art fails to describe all the features, and provide any incentive which would lead a person to the features of the present invention. The independent claims therefore define over the prior art.

Applicant notes that claim 22 specifically sets forth that the illuminating device emits light at a longitudinal position of the image deviation device. As described above, the prior art does not teach nor suggest emitting light and receiving images at a same longitudinal or axial position, and therefore claim 22 clearly defines over the prior art.

Claim 1 sets forth that the light exit is disposed besides the device for image deviation at the axially outer end of the lens head. Applicant notes that element 31 in Czarnek is not positioned at an axially outer end of a lens head. In fact element 31 in Czarnek is clearly spaced from an end face 15 by mirror 27 and image plane 25. Therefore Czarnek does not teach the relative positioning set forth in claim 1. With regards to Hayes, elements 12 and 12A are clearly not at an axially outer end of a lens head, especially a lens head which includes a device for image deviation. Therefore the relative positioning features in claim 1 of the illuminating device and the image deviation device are clearly not taught nor suggested in the combination of the

prior art.

Independent claim 20 sets forth that the light exit of the illuminating device is disposed circumferentially beside said device for image deviation. In Figure 2 of the present invention, the preferred embodiment of the image deviation device is mirror or prism 9. The axial direction is vertical in Figure 2, and the circumferential direction in Figure 2 is horizontal or left-right. The preferred embodiment of the illuminating device are light exits 15 and 16 in Figure 2, and these are clearly circumferentially beside the mirror 9. As described above, the prior art does not teach such a relative positioning of an illuminating device and an image deviation device. Independent claim 20 therefore clearly defines over the combination of the prior art.

Independent claim 20 sets forth that the exit point of the light is disposed in the area of the axially outer end of the lens head. As described above, this is not taught not suggested in the prior art, and therefore claim 19 further defines over the prior art.

Claim 23 sets forth that the image deviation device is receivable of the external image over a longitudinal image distance. In the preferred embodiment, the longitudinal image distance is the longitudinal distance between the bottom of prism 9 and the top of prism 9 in Figure 2. Claim 23 further sets forth that the illuminating device emits the light at a position within the longitudinal image distance. In Figure 2, light exits 15 and 16 are clearly within the longitudinal image distance which is the top and bottom of prism 9. The prior art clearly does not teach nor suggest emitting light at such a longitudinal position, and claim 23 therefore further defines over the prior art.

Claim 24 sets forth that the longitudinal image distance has one longitudinal end at the

farthest longitudinal distance of the head. This further emphasizes the feature that the image deviation device is positioned at the utmost end of the head. Claim 24 also sets forth that the illuminating device emits a light at position adjacent the farthest longitudinal distance. One embodiment of this feature is shown in Figure 2, where the light exits 15 and 16 are adjacent the bottom edge of the prism 9. This feature is not taught nor suggested in the prior art, and claim 24 therefore further defines over the prior art.

Claim 25 sets forth that the head includes a web longitudinally extending along one side of the image deviation device. This web is shown in Figure 2 by either of elements 13 or 14. Claim 25 further sets forth that the web extends to, or less than, the farthest longitudinal distance. In the embodiment of Figure 2, the web extends to the bottom of prism 9. This is beneficial since the web 13 or 14 can then both serve as a support for the prism 9, and as a protective element for the bottom edge of prism 9. In some applications, the bottom edge of the prism 9 might not need protection, or it may be desirable to get the bottom edge of the prism 9 as close to the printed circuit board as possible. In these type of applications, the webs do not extend all the way to the bottom of the prism 9. This feature is further not taught nor suggested in the prior art, and therefore claim 25 further defines over the prior art.

Claim 28 sets forth that each of the webs defines an opening for emitting light from the illuminating device. Applicant finds no teaching nor suggestion of two separate webs on opposite sides of an image deviation device emitting light, and therefore claim 28 further defines over the prior art.

Applicant further notes that the present invention satisfies a long felt need in inspection


apparatus, especially with regard to solder connections between an electrical component and a board. The present invention is also a tremendous commercial success which further indicates that the present invention is not obvious in view of the prior art. With this request for reconsideration, Applicant is submitting an Affidavit attesting to the long felt need and commercial success.

The present invention is an improvement in the prior art, since it allows the capturing and presenting of an image between the bottom of an electrical component, and the top of the circuit board to which it is attached. As the Examiner can appreciate, especially from the present application, this gap is very small, less than one millimeter. The prior art of Czarnek is not designed to capture images from such a location. The structure of Czarnek clearly prevents the capturing of such an image. The reference of Hayes is also clearly not intended to capture an image from a gap under an electrical component. Instead Hayes is concerned with viewing connectors which are spaced from the component. The lighting of Hayes would be completely inappropriate to viewing underneath an electrical component. If the device of Hayes were used, the connections underneath the electrical component would be shadowed and not viewable. The present invention is an improvement over the prior art in that it allows the capture of an image from the gap underneath an electrical component. Applicant respectfully requests protection for this improvement.

If the examiner has any comments or suggestions which would further favorable prosecution of this application, the Examiner is invited to contact Applicant's representative by telephone to discuss possible changes. At this time Applicant respectfully requests

reconsideration of this application, and based on the above amendments and remarks,  
respectfully solicits allowance of this application.

Respectfully submitted  
for Applicant,

By:   
Theobald Dengler  
Registration No. 34,575  
McGLEW AND TUTTLE, P.C.

TD:sk  
70179.3

Encls.: Affidavit

DATED: May 25, 2001  
SCARBOROUGH STATION  
SCARBOROUGH, NEW YORK 10510-0827  
(914) 941-5600

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BY:  DATE: May 25, 2001



05-29-01

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05/25/01



JC945 U.S. PTO

## IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Attorney Docket No. 70179JC903 U.S. PTO  
09/866400

Hon. Commissioner of Patents  
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Washington, D.C. 20231

Sir:

1. This is a request for filing a:

(X) Continuation Application Under 37 CFR §1.53(b)

of pending prior application no. 09/394,732 filed on September 13, 1999 for  
APPARATUS AND METHOD FOR THE VISUAL INSPECTION IN  
PARTICULAR OF CONCEALED SOLDERED JOINTS wherein the inventors are:

Mark CANNON

Using the enclosed specification of 26 pages and 28 claims.

The entire disclosure of the above mentioned pending prior application, is considered to be part of the disclosure of the accompanying application and is hereby incorporated by reference therein.

2. Prior Application Information: Examiner: Pham, H.  
Group/Art Unit: 2877

3. X The filing fee is calculated below:

CLAIMS AS FILED, LESS ANY CLAIMS CANCELED BY AMENDMENT

	<u>FILED</u>	<u>EXTRA</u>	<u>RATE</u>	<u>FEE</u>
Total claims	28	8	\$18/\$9	\$72.00
Independent Claims	4	1	\$80/\$40	\$40.00

Multiple Dependant Claims No

Basic Filing Fee: \$ 355.00

Total Filing Fee: \$ 467.00

09/866400 09/866400  
09/866400 09/866400

4. X The Commissioner is hereby authorized to charge any fees which may be required, or to credit any overpayment to our Deposit Account No. 13-0410.
5. X A check in the amount of \$ 467.00 is enclosed.
6.     Cancel claims
7.     Amend the specification by inserting before the first line the sentence:  
-- This is a Continuation of application Serial No. 09/394,732 filed September 13, 1999, and the entire disclosure of this prior application is considered to be part of the disclosure of the accompanying application and is hereby incorporated by reference therein.--
8. X Formal drawings are enclosed.  
[Total Sheets: 3]
9. X The prior application is assigned to ERSA GmbH as recorded under Reel 011541 and Frame 0034. Copies of the recorded assignment are enclosed and the assignment carry over to the present application.
10. X Oath or Declaration [Total Pages: 2 ]
- a.     Newly Executed (original or copy)
- b. X Copy from a prior application (37 C.F.R. § 1.63(d))
11. X Any Convention priority claimed in the parent application is hereby claimed for this application.
12.     A preliminary amendment is attached.
13. X Small Entity status as claimed in the parent application is still proper and hereby claimed for this application. A copy of the Small Entity document from the parent application is enclosed.
14. ACCOMPANYING APPLICATION PARTS.

    English Translation Document  
X Information Disclosure Statement/PTO Form 1449  
    Copies of IDS Citations  
X Return Receipt Postcard (MPEP 503)  
    Certified Copy of Priority Document  
X Request for Reconsideration  
X Other Affidavit

15. X CORRESPONDENCE ADDRESS BELOW:

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Signature: 

Date: May 25, 2001

TD:sk

70179.2

DATED: May 25, 2001

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SCARBOROUGH, NEW YORK 10510-0827

By: 

Date: May 25, 2001

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Re: ATTORNEY DOCKET: 70179  
Customer Number: 000023872

Sir:

Attached please find the complete application papers and Small Entity fees in the above-identified application which are being placed in the U.S. Mail today, May 25, 2001, as Express Mail number EL151019508US.

A copy of the Express Mail receipt is also attached.

Respectfully submitted  
for Applicant(s),

By:



Theobald Dengler  
Reg. No. 34,575  
McGLEW AND TUTTLE, P.C.

TD:sk

Enclosures - Complete Application Papers and Fees  
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BY: Shenit Kuster DATE: May 25, 2001

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Docket # 70179

***APPARATUS AND METHOD FOR THE VISUAL INSPECTION IN  
PARTICULAR OF CONCEALED SOLDERED JOINTS***

**RELATED APPLICATIONS**

This is a Continuation of application Serial No. 09/394,732 filed September 13, 1999<sup>✓</sup>, and  
the entire disclosure of this prior application is considered to be part of the disclosure of the  
accompanying application and is hereby incorporated by reference therein.

*now abandoned*

**FIELD OF THE INVENTION**

The invention relates to an apparatus for the visual inspection in particular of concealed  
soldered joints, in particular between an electric or electronic component disposed on the surface of  
a printed circuit board and the printed circuit board.

## BACKGROUND OF THE INVENTION

In the field of soldering technology, in particular with the use of SMDs (Surface Mounted Devices), and here in turn in particular with so-called BGAs (Ball Grid Arrays), chip scale packages (CSPS) and Flip Chips (FCs), the problem arises that because of the small gap height between the underside of the components and the printed circuit board the quality of the soldered joint both of the outer and of the inner pin arrays with the corresponding contact points of the printed circuit board can no longer be checked merely by visual inspection. The corresponding electric or electronic components or assemblies are therefore in general subjected to an electric function test after the soldering. This is first of all, however, time-consuming and therefore expensive and can secondly only supply information as to whether the soldered joints conduct current or whether open or short-circuits occur. Information on the quality and hence solidity of the individual soldered joints and expected life-time cannot be supplied by this test method.

It is further known to check soldered joints non-destructively by means of x-rays. With this known method also it is possible in the end to check only undesirable soldering jumpers between adjacent pins, which cause a short-circuit, or the correct position of the pins of the components on the contact points of the printed circuit board; a statement on the quality of the individual soldered joints or the visual quality of the surface of the individual soldered joints or for example on undesirable flux residues in the area of the solderings is not possible. In addition such units are very expensive to procure and maintain and the application of this known method is not completely risk-free in terms of exposure to radiation. Furthermore, such units can only be operated by highly trained and specialized persons.

A further known method for determining the quality of a soldered joint is the production of

a micrograph in cross-section through the respective soldered joint. Although it is certainly possible in this way to obtain reliable information on the quality of the soldered joint, for example on sufficient melting of the solder point of the component and hence satisfactory wetting of the contact point on the printed circuit board, a destructive test method is nevertheless involved here, which can be used only on a random sample basis for the drawing of conclusions on the operating parameters of the soldering process. Moreover, a visual inspection of the surface of the individual soldered joints is also not possible in this case.

Finally, there are known from the field of medicine and engineering endoscopes with illuminating devices, with which inaccessible areas can be inspected visually. The known endoscopes have a substantially tubular layout, at the axially outer end of which a deflection unit with illumination is disposed, which deflects the light exiting out of the tubular arrangement in the gap direction or deflects the gap image in the direction of the ocular. Because of its type of construction, however, viewing into gaps of small height, in particular in the range below 1 mm gap height, as is regularly the case in particular with BGAs and other SMDS, is not possible.

## SUMMARY AND OBJECTS OF THE INVENTION

Starting from this prior art it is the object of the present invention to create a generic apparatus which permits the visual inspection of in particular concealed soldered joints non-destructively in a comparatively simple and cost-effective manner.

According to the invention, an apparatus for the visual inspection of concealed soldered joints, between an electric or electronic component disposed on the surface of a printed circuit board and the printed circuit board, is provided with an ocular unit, a lens head, an image transmission unit



for transmitting the image received by the lens head to the ocular unit and an illuminating device for illuminating the soldered joints to be tested. The lens head comprises a device for image deviation which extends up to the axially outer end of the lens head. The illuminating device is disposed in the lens head in such a way that the exit angle of the light of the illuminating device out of the lens head is substantially equal to the deviation angle of the image deviation. The exit point of the light is disposed next to the device for image deviation in the area of the axially outer end of the lens head.

It is also a further object of the invention to provide a method with which the quality of a soldered joint between an electric or electronic component disposed on the surface of a printed circuit board or similar, in particular an SMD or BGA component, and the printed circuit board is checkable in a simple manner.

According to the invention the apparatus for the visual inspection of concealed soldered joints comprises, in particular between an electric or electronic component soldered to a printed circuit board, for example a BGA, and the printed circuit board, for the checking of the quality of the soldered joint, first and foremost an ocular unit, a lens head, an image transmission unit for transmitting the image received by the lens head to the ocular unit and an illuminating device for illuminating the soldered joints to be tested. In other words, the apparatus according to the invention comprises first and foremost the basic constructional form of an industrial or medical endoscope. Further there is provided in the area of the lens head in a manner first and foremost also known per se a device for image deflection.

In contrast to the known endoscopes, however, in which the lens or the deflection device is by virtue of the type of construction located at least a short distance from the axially outer "distal"

end of the lens head, with the apparatus according to the invention the device for image deflection extends up to the axially outer end of the lens head. For this reason alone the image exit or image entry point of the lens can be placed considerably closer to the printed circuit board in comparison with the prior art, so that gaps of smaller height or soldered joints disposed therein are visually inspectable.

Likewise in contrast to the known endoscopes, in which the illuminating device or the light exit is disposed above or below the lens or the deflection unit, whereby the gap height to be reached visually is increased and/or an undesirable light shadow is generated in the gap area, according to the invention the illuminating device is disposed in the lens head in such a way that the exit angle of the light of the illuminating device from the lens head is substantially equal to the deviation angle of the image deviation and the exit point of the light is disposed next to the device for image deviation in the vicinity of the axially outer end of the lens head. This means in other words that on the one hand the illuminating device is disposed at substantially the same height, referred to the printed circuit board surface or gap plane, as the image exit or image entry point of the lens and on the other the image illumination takes place without any vertical shading.

Overall, soldered joints in gaps with a height of less than 1 mm and well below this can be inspected visually in a simple manner with the apparatus according to the invention. This means in particular that the individual soldered joints for example in BGAS, CSPs or FCs which as a rule have a gap height of approx. 0.02 to 0.8 mm between component underside and printed circuit board, are visually checkable nondestructively for soldering defects, undesirable jumper formation, contaminations and similar.

In basically any manner the exit of the light of the illuminating device can take place

monolaterally at the lens head. According to a preferred embodiment of the invention, however, the exit of the light of the illuminating device from the lens head takes place bilaterally next to the device for image deflection, whereby a regular illumination of the field of view is ensured.

5 The deflection or deviation of the image in the lens head from the direction of the object to be observed in the direction of the ocular can likewise take place in any manner, for example in the simplest case by means of a deviating mirror. Preferably, however, the device for image deviation comprises a deviating prism, in which the deviation takes place in manner known per se. In comparison with mirror deviation, therefore, in particular the visual quality of the image can be improved and in particular also the image exit or image entry point of the lens be moved further  
10 downwards, namely in the direction of the axially outer end of the lens head.

The deviation angle of the device for image deviation is basically arbitrary and can lie between 0 and 180 degrees. The deviation angle further depends substantially on the angle at which the endoscope of the apparatus is positioned relative to the printed circuit board surface. Preferably the deviation angle comes to substantially 90 degrees. This means in other words that the apparatus according to this embodiment of the invention is, referred to the optical axis between lens and ocular,  
15 positioned substantially at right angles to the printed circuit board and hence to the gap plane. The apparatus can therefore also be used with densely equipped printed circuit boards and hence comparatively narrow gaps between the components to be checked.

20 In particular if it is not only the outer soldered joints in the edge area of the component that have to be checked, the lens is according to a further particularly preferred embodiment of the invention constructed in such a way that the depth of field area of the image or the focus distance correspond to at least half the component size, for example half the component width, half the

component length or half the component diameter. In this way the whole of the gap interior can be checked visually by the inspection of mutually opposite sides of the component. The depth of field area of the lens can further be pre-set in manner known per se for example through the focal length of the lens.

5 According to a particularly preferred embodiment the lens head comprises a housing with at least one laterally open recess tapering towards the axially outer end of the lens head and bounded on both sides by flange-type webs. The deviating prism or the deviating mirror is disposed in this housing in such a way that the free surface of the deviating prism, i.e. that facing the gap, or the mirror surface in the recess faces outwards, referred to the housing and the recess, and the lower lateral edge of the deviating prism or the deviating mirror seals the lens head towards the axially outer end. This means in other words that the lower end of the deviating prism or the deviating mirror can be brought to rest directly against the printed circuit board, in order to guarantee an image deviation also into extremely low gaps, while the lateral edges of the prism or the mirror are protected against damage by the flange-type webs and the prism or the mirror is simultaneously fixable by these webs. In this embodiment the light exits of the illuminating device can further be disposed in the flange-type webs.

According to a further preferred embodiment the illuminating device comprises at least one glass fiber bundle which is connectable with its first axial end to a light source, whether the latter be disposed externally or else in or on the apparatus, and forms with its second axial end the light exit of the illuminating device on the lens head. There can be achieved in simple manner by the use of a glass fiber bundle in particular a light exit which, if there is adequate illumination intensity, has a sufficiently small diameter for illuminating a narrow gap. If two or more light exits are provided

in the lens head, the respective glass fiber bundles can be combined into one bundle between light exit and light source and be fed to a common light source.

The transmission of the gap image from the lens head to the ocular can take place for example by means of a lens or mirror system. Preferably however the apparatus according to the invention comprises for the image transmission at least one further glass fiber bundle, which can be coupled optically with its first end to the unit for image deviation, in particular the deviating prism, and with its second end to the ocular.

In principle all kinds of soldering defects can be checked and determined visually with the embodiments described above, both those in the edge area and, if there is a sufficient depth of field of the lens, in the inner area of the soldering field for example of a BGA. In particular, but by no means exclusively, if undesirable soldering jumpers causing a short circuit are to be detected, namely jumpers between adjacent "solder pins" of a BGA, CSP or FC with a large number of soldering points, a second illuminating device is provided according to a particularly preferred embodiment of the invention, which is positionable opposite the lens head substantially in the viewing or in the image direction of the apparatus, referred to the gap plane, and illuminates in the direction of the lens head. It is thus possible in a simple manner, with viewing through the gap intervals between the individual rows of the soldering points, for a short-circuit jumper to be eliminated by recognition of the counterlight source and, conversely, for an undesirable jumper to be determined in an unambiguous manner if the counterlight source cannot be seen.

According to a further embodiment of the invention the second illuminating device comprises a counterlight head with a housing with at least one laterally open recess tapering towards the axially outer end of the counter- light head, wherein in the housing a deviating prism or a deviating mirror,

which is connectable to a light source via a glass fiber bundle, is disposed in such a way that the free surface of the deviating prism or the mirror surface in the recess faces outwards and the lower lateral edge of the deviating prism or of the deviating mirror seals the counterlight head towards the axially outer end. This means in other words that the light deviation and the light exit take place via the prism, which in this embodiment does not have an image-transferring function of any kind. Because of the previously described shape the prism and hence the light exit can again be placed close to the surface of the printed circuit board and therefore in the gap plane.

According to an alternative embodiment to the latter the second illuminating device can comprise a counterlight head which is of substantially identical construction to the lens head of the apparatus. In this embodiment the counterlight head and the lens head can respectively serve simultaneously or alternately as an illuminating device and/or image detector, so that simultaneously or alternately the gap can be checked from both sides for example of a BGA. To this end the prism of the counterlight head can be couplable reversibly with the ocular of the lens head or else with a separate ocular.

In particular if the counterlight head serves simply as a counterlight source, according to a further embodiment of the invention the glass fiber bundle at least of the second illuminating device can run in a flexible spiral tube. In this way firstly the glass fiber bundle is reliably protected against mechanical damage and secondly the counterlight head can thereby in conformance with BGAs of varying dimensions be adjusted in particular as regards its distance from the lens head.

The illuminating device of the counterlight head and the illuminating device of the lens head can be coupled to different light sources in any manner. Preferably, however, the glass fiber bundles of the lens head and of the counterlight head are connectable to the same light source. An overall

structural layout which is simple and cost-effective is thereby obtained.

According to a further embodiment the first and/or the second illuminating device or the light source of the first and/or second illuminating device can be adjustable in their luminous strength or light intensity.

5 It is of critical importance for the invention that the lens head is illuminatable by the counterlight source. To this end the lens head and the second illuminating device are preferably couplable via a linkage, rack or similar such that an exactly defined relative position of lens head and illuminating device, in particular counterlight head, is adjustable.

According to a particularly preferred embodiment the linkage or rack comprises for this purpose a freely projecting bracket which is fixable substantially rigidly to a housing section of the apparatus between lens head and ocular or is part of said housing section. In this embodiment the bracket comprises, displaceable in longitudinal direction in a guide element, a holding device in which the second illuminating device is fixable indirectly or directly and with which in particular the axial distance between lens head and counterlight head is adjustable.

10 The image of the gap or of the soldered joints disposed therein which is transmitted by the lens to the ocular can be inspected directly by an observer at the ocular. According to a preferred embodiment, however, an image-recording, image-converting and/or image-processing device of an electronic, magnetic or optical kind is couplable indirectly or directly in the vicinity of the ocular. This can be for example a video or television camera whose CCD image sensor is connectable to the  
20 ocular directly or indirectly via a corresponding lens. The video image so received can be passed to a screen and/or be subjected to an image processing in a computer. The checking of soldered joints beneath a BGA can thereby be automated in basically any manner for example by comparison

of the image with reference images. Furthermore, the standoff height or gap can be measured directly on a video screen or by a program of a computer to detect a critical height which can be a measure of the quality of the soldered joint.

The apparatus according to the invention can in manner known per se be disposed on an X-Y table on which a printed circuit board-component soldered joint to be investigated can be brought into the test position below the apparatus or, conversely, the apparatus can be brought into the test position above the printed circuit board-component soldered joint.

According to the invention the apparatus described above can in a particularly advantageous manner be used in a method for checking the quality of the soldered joint between an electrical or electronic component arranged on the surface of a printed circuit board or similar, in particular an SMD, BGA, CSP or FC component, and the printed circuit board. The component to be investigated in terms of the soldered joint with the printed circuit board comprises, arranged in rows and gaps after the manner of a matrix, a large number of solder pins or solder points which are solderable with a corresponding number of contact points complementary as to shape and function disposed on the printed circuit board. The method according to the invention comprises the following method steps:

a) In a first method step first of all a visual examination is made of the soldered joints of the outermost row of soldered joints of a first side of the component to be tested, wherein the component is moved stepwise according to the spacing of the solder point rows or gaps past the lens head of the apparatus or, conversely, the lens head of the apparatus is moved step-wise past the component. It is not absolutely necessary for all the solder points to be checked here; instead, a comparatively reliable finding on the overall quality of the soldering can be obtained simply by checking of the corner soldering points. Moreover, use can be made, in evaluating the quality of the soldered joint,



both of the surface of the soldered joint, in particular also flux residues, and for example the geometrical form of the solder point, in particular the "crowning" at the solder points of a BGA as a measure of a sufficient melting during the soldering process and the coplanarity of component and printed circuit board. The distance or the standoff height of the component underside from the printed circuit board surface can be a further measure of the quality of the soldered joint or at least of sufficient melting of the solder points during the soldering process. The latter can easily be measured as the gap height with an apparatus according to the invention.

b) In further method steps the component or the apparatus is rotated respectively through 90 degrees, wherein a visual examination is subsequently made in each case of the outermost rows of soldered joints of the further sides of the component analogously to method step a).

c) For the reliable determination of undesirable jumpers between neighboring solder pins, which can lead to electrical failure of the component, there takes place according to the invention in a further method step a visual examination of the channels formed between the respective gaps or rows for optical visibility.

Method steps a) to c) do not necessarily have to be carried out in this time sequence. Instead method step c) in particular can be carried out at the same time as method steps a) and b) during the step-wise moving of the component past the lens head or, conversely, the lens head past the component.

According to a preferred embodiment method step c) is carried out with counterlight, whereby a particularly easy and fast recognition of undesirable short-circuit jumpers is obtained.

In order to fully check a component or the soldered joints between the component and the printed circuit board, with method steps a) and b), at the same time or staggered in time, the soldered

joints of the inner rows can be checked visually for soldering defects by viewing into the channels formed between the gaps or rows. In particular co-planarity defects between component and printed circuit board in the gap interior can thereby be determined easily and reliably.

The various features of novelty which characterize the invention are pointed out with particularity in the claims annexed to and forming a part of this disclosure. For a better understanding of the invention, its operating advantages and specific objects attained by its uses, reference is made to the accompanying drawings and descriptive matter in which preferred embodiments of the invention are illustrated.

## BRIEF DESCRIPTION OF THE DRAWINGS

In the drawings:

Fig. 1 is a diagrammatic representation of an embodiment of the apparatus according to the invention in elevation,

Fig. 2 is an enlarged diagrammatic partly cut-away view of the lens head of the embodiment according to Fig. 1, wherein the lens head is rotated through 90 degrees compared with the view according to Fig. 1;

Fig. 3 is an enlarged diagrammatic view corresponding to Fig. 2 of the counterlight head of the apparatus according to the invention;

Fig. 4a is a sectional view taken along line 4a-4a of Fig. 2;

Fig. 4b is a sectional view taken along line 4b-4b of Fig. 2.

## DETAILED DESCRIPTION

## OF THE PREFERRED EMBODIMENT

The apparatus 1 according to the invention shown in Fig. 1 has substantially the outer form of an endoscope. The apparatus 1 is further fitted with a lens head 2, which in manner known per se contains a lens, an ocular unit 3 and an image transmission unit 4 for transmitting the image received by the lens head 2 to the ocular unit 3. The image transmission unit 4 is disposed in a substantially tubular housing section 5 of the apparatus 1 and comprises a glass fiber bundle 18 indicated only diagrammatically in the view according to Fig. 2, which couples the lens head 2 with the ocular unit 3 visually, that is to say transmitting an image. As an alternative, there may be a series of lenses between the lens head 2 and the ocular unit which transmit and eventually magnify the image.

The lens head 2, which is shown enlarged in Fig. 2, comprises a housing 6, preferably of stainless steel, which is formed funnel-shaped in cross section (cf. Fig. 1). The housing 6 is provided with a recess 7, which in the view according to Fig. 2 is substantially square-shaped. The recess 7 is further open both downwards, that is to say towards the axially outer end 8 of the apparatus 1, and laterally, that is to say towards the observer in the view according to Fig. 1. In the recess 7 a deviating prism 9 is disposed in such a way that the free prism face 10 faces outwards (to the left in the view according to Fig. 1) and a deviation or deflection of the optical path by 90 degrees takes place out of the vertical axis 11 formed by ocular unit 3 and lens head into the horizontal axis 12 and vice-versa.

The recess 7 is bounded laterally by two flange-type webs 13 and 14. These webs serve firstly for the fixing and for the protection of the deviating prism 9 against mechanical damage and secondly light exits 15 and 16 which are part of an illuminating device are disposed in the axially

outer ends of the webs 13 and 14. The light exits 15 and 16 are in this embodiment formed by the free axial ends respectively of a glass fiber bundle, which free axial ends are led through the lens head 2 and the housing section 5 to a glass fiber connection 17 which serves for the feeding of the light of a light source (not shown), so that both light exits 15 and 16 are fed from the same light source. The glass fiber bundles are so oriented in the vicinity of the light exits so that the exit angle of the light is substantially equal to the deviation angle of the image deviation, whereby the whole of the visually attainable field of view is illuminatable without any vertical shadowing.

In Fig. 1 the apparatus 1 according to the invention, more precisely the lens head 2, is placed as normal on a printed circuit board or held only a short distance above the printed circuit board surface. There is fixed to the printed circuit board in known manner an electronic component 20 in the form of a BGA (Ball Grid Array) by soldering via the solder points 21. The gap 22, shown with enlarged thickness not to scale, between the component underside and the printed circuit board surface has as a rule a gap height of between 0.02 and 0.8 mm. By virtue of the features of the invention which are described above, in particular the arrangement of the deviating prism 9 directly up to the axially outermost distal end of the lens head 2, the image exit or image entry point of the prism and hence of the lens as a whole can be moved into the gap area, whereby the gap and hence the interior soldered joints disposed therein are visually accessible, wherein moreover, because of the light exit at substantially the same axial height, or longitudinal position, above the printed circuit board surface as the image exit or image entry point, sufficient illumination and hence good observability is ensured in the gap area.

As shown in Fig. 2, the deviating prism 9 is receivable of the external image over a longitudinal or axial image distance which extends from the bottom to the top of prism 9 in Figure

2. The light exits 15, 16 emit the light at a position within this longitudinal image distance. The longitudinal image distance has one longitudinal or axial end at a farthest longitudinal distance of the lens head 2, which is the bottom of lens head 2 and prism 9 in Figure 2. The light exits 15, 16 emit the light at a position adjacent this farthest longitudinal distance.

5 The embodiment of an apparatus 1 according to the invention which is shown in Fig. 1 is further equipped with a counterlight head 23. The counterlight head 23 comprises a housing 24 (cf. Fig. 3) which is provided in analogous manner to the housing 6 of the lens head 2 with a recess 25 and a deviating prism 26 disposed therein as described above for the lens head 2. In contrast to the lens head 2, however, the deviating prism 26 is combined visually not with the ocular unit 3, but rather via a glass fiber bundle 27, which is accommodated in a flexible spiral tube 28, in particular of stainless steel, with the glass fiber connection 17 and hence with the same light source (not shown) as the illuminating device of the lens head 2. The deviating prism 26 serves in particular for the introduction, directed substantially onto the lens head 2, of counterlight into the gap 22.

10 In the area of the housing section 5 a freely projecting bracket 29 is fixed to the apparatus 1. A groove-type guide element 30 is moreover formed in the bracket 29, in which a clamping member 31 is accommodated so as to be displaceable axially, that is to say in axial direction of the bracket 29, and fixable by clamping. The glass fiber bundle 27 running in the spiral tube 28 is held in the clamping member 31, so that with the displacement of the clamping member 31 the counterlight head 23 is simultaneously displaceable in the direction of the arrow and hence the exact distance  
20 between counterlight head 23 and lens head 2 is adjustable in particular in conformance with BGA components of differing sizes. Moreover, the bracket 29 may be adjusted vertically and rotated for at least 90° with respect to the housing section 5 to bring the bracket and combined therewith the



WHAT IS CLAIMED IS:

Sub 21  
1. An apparatus for the visual inspection of soldered joints between an electric or electronic component disposed on the surface of a printed circuit board and the printed circuit board, the apparatus comprising:

an ocular unit;

5 a lens head;

an image transmission unit for transmitting the image received by said lens head to said ocular unit; and

an illuminating device for illuminating the soldered joints to be inspected, said lens head comprising a device for image deviation extending up to an axially outermost end of said lens head, said illuminating device being disposed in said lens head to provide a light exit directed toward the soldered joints to be inspected, said light exit being disposed besides said device for image deviation at the axially outer end of said lens head.

2. The apparatus according to claim 1, wherein said light exit of the light of the illuminating device from the lens head is a bilateral exit next to the device for image deviation.

3. The apparatus according to claim 1, wherein the device for image deviation comprises at least one deviating prism or at least one deviating mirror.

4. The apparatus according to claim 1, wherein the deviation angle of the device for image deviation is between 0 and 180 degrees.

5. The apparatus according to claim 4, wherein the deviation angle of the device for image deviation is substantially 90 degrees.

6. The apparatus according to claim 1, wherein the lens head has a focal length such that the depth of field area of the image corresponds to at least half of a largest component size of the component on the printed circuit board.

7. The apparatus according to claim 1, wherein the lens head comprises a housing with at least one laterally open recess tapering towards the axially outer end of the lens head and bounded on both sides by flange-type webs, wherein a deviating prism or deviating mirror is disposed in the housing to cause a free surface of the deviating prism or the mirror surface in the recess faces outwards and the lower lateral edge of the deviating prism or of the deviating mirror seals the lens head towards the axially outer end, and wherein further the light exits of the illuminating device are arranged in the flange-type webs.

8. The apparatus according to claim 1, wherein the illuminating device comprises at least one glass fiber bundle with first and second ends, said first axial end is connectable to a light source and forms with said second axial end the light exit of the illuminating device on the lens head.

9. The apparatus according to claim 1, wherein the image transmission unit comprises at least one glass fiber bundle which is optically couplable with its first end to the unit for image deviation, and with its second end to the ocular unit.



10. The apparatus according to claim 1, wherein a second illuminating device, positionable substantially in a viewing direction of the apparatus opposite the lens head, illuminates in the direction of the lens head.

11. The apparatus according to claim 10, wherein the second illuminating device comprises a counterlight head with a housing with at least one laterally open recess tapering towards the axially outer end of the counterlight head, wherein in the housing a deviating prism or a deviating mirror, which is optically couplable to a light source via a glass fiber bundle, is disposed with the free surface of the deviating prism or the mirror surface in the recess facing outwards and the lower lateral edge of the deviating prism or of the deviating mirror seals the counterlight head towards the axially outer end.

12. The apparatus according to claim 10, wherein the second illuminating device comprises a counterlight head which is of substantially identical construction to the lens head.

13. The apparatus according to claim 10 wherein the glass fiber bundle at least of the second illuminating device runs in a flexible spiral tube.

14. The apparatus according to claim 11, wherein the glass fiber bundle of the lens head and of the counterlight head are connectable to the same light source.

15. The apparatus according to claim 10, wherein the lens head and the second illuminating

device are couplable via a linkage, rack or similar to provide an exactly defined relative position of lens head and second illuminating device is adjustable.

5 16. The apparatus according to claim 15, wherein the linkage or rack comprises a freely projecting bracket which is fixable substantially rigidly to a housing section of the apparatus between lens head and ocular unit or is part of the housing section, wherein the bracket comprises, displaceable in longitudinal direction in a guide element, a holding device in which the second illuminating device is fixable, with which the axial distance between lens head and counterlight head is adjustable.

17. A method for checking the quality of the soldered joint between an electric or electronic component disposed on the surface of a printed circuit board or similar including an SMD, BGA, CSP or FC component, and the printed circuit board, the method comprising the steps of:

10 using an ocular unit with an apparatus including a lens head, an image transmission unit for transmitting the image received by the lens head to the ocular unit and an illuminating device for illuminating the soldered joints to be tested, in which the lens head comprises a deviating prism for image deviation which extends up to the axially outermost end of the lens head, and in which the illuminating device is disposed in the lens head to cause the exit angle of the light of the illuminating device out of the lens head is substantially equal to the deviation angle of the image deviation and the exit point of the light is disposed next to the deviating prism for image deviation in the area of the axially outer end of the lens head, the component comprising, arranged

in rows and gaps after the manner of a matrix, a large number of solder pins, solder balls or solder points which are solderable with a corresponding number of contact points complementary as to shape and function disposed on the printed circuit board;

visually examining the soldered joints of the outermost row of soldered joints of a first side of the component to be tested with the unit, wherein the component is moved step-wise according to the spacing of the solder joint rows or gaps past the lens head of the apparatus or, conversely, the lens head of the apparatus is moved step-wise past the component;

rotating of the component or the apparatus through respectively 90 degrees and visually examining the soldered joints of the outermost rows of soldered joints of the further sides of the component with the unit wherein the component is moved step-wise according to the spacing of the solder joints past the lens head of the apparatus or, conversely, the lens head of the apparatus is moved step-wise past the component; and

visually examining the channels formed between the respective gaps or rows for optical visibility.

18. The method according to claim 17, wherein said visually examining the channels is performed with a counterlight.

19. The method according to claim 17 wherein in addition to said visually examining the soldered joints and said rotating, at the same time or staggered in time, the soldered joints of the inner rows are examined visually for soldering defects by viewing into the channels formed between the gaps or rows.

20. An apparatus for the visual inspection of soldered joints disposed between an electric or electronic component and a substrate, the apparatus comprising:

an ocular unit;

a lens head;

5 an image transmission unit for transmitting the image received by said lens head to said ocular unit; and

an illuminating device for illuminating the soldered joints disposed between the electric or electronic component and the substrate, said lens head comprising an image deviation device for changing the direction of the image path from an incoming direction from between the electric or electronic component and the substrate to an outgoing direction, said image deviation device extending up to an axially outermost end of said lens head, said illuminating device having a light exit to provide a light exit direction substantially toward said incoming direction, said light exit of said illuminating device being disposed circumferentially besides said device for image deviation.

21. The apparatus according to claim 20, wherein said image deviation device changes the direction of the image path by an image deviation angle, said illuminating device having a light source and a light transmission path changing the direction of light from said light source to said light exit by an angle substantially equal to said image deviation angle.

22. A visual inspection apparatus comprising:

an image transmission unit having a longitudinal axis with first and second ends at opposite longitudinal ends, said image transmission unit transmitting an image from said first end to said second end along said longitudinal axis;

5 a head arranged at said first end of said image transmission unit, said head extending a predetermined distance from said first end of said image transmission unit;

an image deviation device arranged in said head and being receivable of an external image at an image axis angularly spaced from said longitudinal axis of said image transmission unit, said image deviation device being feedable of the external image into said first end of said image transmission unit substantially along said longitudinal axis, said image deviation device being receivable of the external image at substantially a farthest longitudinal distance of said head from said transmission device;

an illuminating device in said head, said illuminating device emitting light substantially parallel to said image axis at a longitudinal position of said image deviation device.

23. An apparatus in accordance with claim 22, wherein:

said image deviation device is receivable of the external image over a longitudinal image distance;

said illuminating device emits the light at a position within said longitudinal image distance.

24. An apparatus in accordance with claim 23, wherein:

said longitudinal image distance has one longitudinal end at said farthest longitudinal

distance of said head;

said illuminating device emits the light at a position adjacent said farthest longitudinal  
5 distance.

25. An apparatus in accordance with claim 22, wherein:

said head includes a web longitudinally extending along one side of said image deviation  
device, said web extending to, or less than, said farthest longitudinal distance.

26. An apparatus in accordance with claim 22, wherein:

said head includes a web longitudinally extending along one side of said image deviation  
device, said web extending substantially equal to said farthest longitudinal distance.

27. An apparatus in accordance with claim 25, wherein:

said head includes another web longitudinally extending along another side of said image  
deviation device, said another web extending to, or less than, said farthest longitudinal distance.

28. An apparatus in accordance with claim 27, wherein:

each of said webs define an opening for emitting light from said illuminating device.

## ABSTRACT OF THE DISCLOSURE

An apparatus for the visual inspection in particular of concealed soldered joints is provided, in particular between an electric or electronic component disposed on the surface of a printed circuit board and the printed circuit board. The apparatus includes with an ocular unit, a lens head, an image transmission unit for transmitting the image received by the lens head to the ocular unit and an illuminating device for illuminating the soldered joints to be tested. The lens head includes a device for image deviation which extends up to the axially outer end of the lens head, and in which the illuminating device is disposed in the lens head in such a way that the exit angle of the light of the illuminating device out of the lens head is substantially equal to the deviation angle of the image deviation. The exit point of the light is disposed next to the device for image deviation in the area of the axially outer end of the lens head.

# DECLARATION FOR PATENT APPLICATION

Docket No. 63896

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below next to my name.

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled: APPARATUS AND METHOD FOR THE VISUAL INSPECTION IN PARTICULAR OF CONCEALED SOLDERED JOINTS

the specification of which

(Check one) ☒ [X] is attached hereto.  
☐ [ ] was filed on \_\_\_\_\_ as  
Application Serial No. \_\_\_\_\_  
and was amended on \_\_\_\_\_.

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose information which is material to the patentability of this application in accordance with Title 37, Code of Federal Regulations, 1.56.

I hereby claim foreign priority benefits under Title 35, United States Code, 119 of any foreign application(s) for patent or inventor's certificate listed below and have also identified below any foreign application for patent or inventor's certificate having a filing date before that of the application on which priority is claimed:

Prior Foreign Application(s)

198 47 913.1  
(Number)

GERMANY  
(Country)

19-10-1998  
(Day/Month/Year filed)

Priority Claimed  
YES

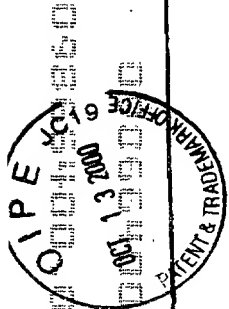
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(Number)

\_\_\_\_\_  
(Country)

\_\_\_\_\_  
(Day/Month/Year filed)

I hereby claim the benefit under Title 35, United States Code, 120 of any United States application(s) listed below and, insofar as the subject matter of each of the claims of this





HRB 23 W

Handelsregister - Abt. B - des Amtsgerichts Taubertal

Firma Sitz Gegenstand des Unternehmens	a) Firma b) Sitz c) Gegenstand des Unternehmens	Grundkapital oder Stammkapital DM/EUR	Vorstand Persönlich haftende Gesellschafter Geschäftsführer Abwickler	Prokura	Rechtsverhältnisse	a) Tag der Eintragung und Unterschrift b) Bemerkungen
1	2	3	4	5	6	7
15	<p>Betr.: ERSÄ Löttechnik GmbH Wertheim, Leonhard-Karl-Straße 24</p> <p>-Eintragungsmitteilung-</p> <p>Verteiler: a) THK, Hailbronn b) FA, TBB c) Postamt Lauda/Wertheim d) Notar Dr. Ekkehard Moeser e) zu: KIR.93S362.JAF # 144387 (FRA 269E01)</p>					e) 03. Mai 2000
	a) ERSÄ GmbH				Die Gesellschafterversammlung vom 12. April 2000 hat die Änderung des Gesellschaftsvertrags in § 1 (Firma) beschlossen. Die Firma ist geändert.	

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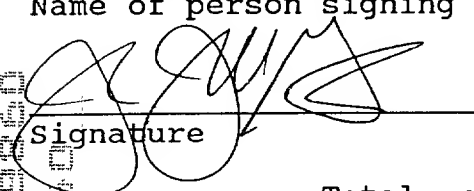
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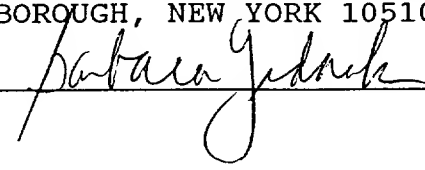
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McGLEW AND TUTTLE, P.C., SCARBOROUGH STATION,  
SCARBOROUGH, NEW YORK 10510-0827

By:  Date: September 13, 1999

## ASSIGNMENT OF U.S. PATENT APPLICATION

WHEREAS, Mark CANNON, a citizen of United States, located (residing) at: Ebinger Str. 26c, D-76139 Karlsruhe, GERMANY has invented certain new and useful improvements in an invention entitled: *APPARATUS AND METHOD FOR THE VISUAL INSPECTION IN PARTICULAR OF CONCEALED SOLDERED JOINTS* and corresponding to 198 47 913.1 for which he/she is about to make/ has made application for Letters Patent of the United States of America;

**AND, WHEREAS, ERSA Loettechnik GmbH, located and doing business at: Leonhard-Karl-Str. 24, D-97877 Wertheim, GERMANY (hereinafter referred to as Assignee) is desirous of acquiring an interest herein and in the Letters Patent to be obtained therefor from the United States;**

NOW THEREFORE, be it known by all whom it may concern, that for and in consideration of the sum of One Dollar (\$1.00) (or the equivalent thereof in foreign currency) and other valuable consideration to me in hand paid, the receipt of which is hereby acknowledged, I have assigned, sold and set over and by these presents do assign, sell and set over unto the said Assignee for the territory of the United States of America and not elsewhere, the full and full exclusive right, title and interest in and to the said invention, as fully set forth and described in the specification prepared and executed by me on \_\_\_\_\_ filed \_\_\_\_\_, Ser. No. \_\_\_\_\_ preparatory to obtaining Letters Patent therefor; said invention, application and Letters Patent to be held and enjoyed by the said Assignee for its own use and behoof and for the use and behoof of its successors and assigns to the full end of the term for which said Letters Patent is granted, as fully and entirely as the same would have been held by me had this Assignment and sale not been made.

IN WITNESS WHEREOF, I have hereunto set my hand this 8 day of September 19 99

**Mark CANNON**

**In the presence of:**

McGLEW AND TUTTLE, P.C.  
SCARBOROUGH STATION, SCARBOROUGH NY 10510-0827

ATTORNEY DOCKET NO. 63896

Applicant: CANNON

Serial No.:

Filed:

For: APPARATUS AND METHOD FOR THE VISUAL INSPECTION IN PARTICULAR OF CONCEALED SOLDERED JOINTS

VERIFIED STATEMENT (DECLARATION) CLAIMING  
SMALL ENTITY STATUS  
(37 CFR 1.9(f) and 1.27 (c)) SMALL BUSINESS CONCERN

I hereby declare that I am

- ☐ the owner of a small business concern identified below:  
☐ an official of the small business concern empowered to act on behalf of the concern identified below

NAME OF CONCERN ERSA Loettechnik GmbH

ADDRESS OF CONCERN Leonhard-Karl-Str. 24, D-97877 Wertheim, GERMANY

I hereby declare that the above identified small business concern qualifies as a small business concern as defined in 13 CFR 121.3-18, and reproduced in 37 CFR 1.9(d), for purposes of paying reduced fees to the United States Patent and Trademark Office, in that the number of employees of the concern, including those of its affiliates, does not exceed 500 persons. For purposes of this statement, (1) the number of employees of the business concern is the average over the previous fiscal year of the concern of the persons employed on a full-time, part-time or temporary basis during each of the pay periods of the fiscal year, and (2) concerns are affiliates of each other when either, directly or indirectly, one concern controls or has the power to control the other, or a third party or parties controls or has the power to control both.

I hereby declare that rights under contract of law have been conveyed to the remain with the small business concern identified above with regard to the invention, entitled APPARATUS AND METHOD FOR THE VISUAL INSPECTION IN PARTICULAR OF CONCEALED SOLDERED JOINTS by inventor(s): Mark CANNON described in

- ☐ the specification filed herewith  
☐ application serial no. \_\_\_\_\_, filed \_\_\_\_\_  
☐ patent no. \_\_\_\_\_, issued \_\_\_\_\_

If the rights held by the above identified small business concern are not exclusive, each individual, concern or organization having rights to the invention is listed below\* and no rights to the invention are held by any person, other than the inventor, who could not qualify as a small business concern under 37 CFR 1.9 (c) if that person made the invention or by any concern which would not qualify as small business concern under 37 CFR 1.9 (d) or a nonprofit organization under 37 CFR 1.9 (e). \*NOTE: Separate verified statements are required from each named person, concern or organization having rights to the invention averring to their status as small entities. (37 CFR 1.27)

NAME \_\_\_\_\_  
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☐ [ SMALL BUSINESS CONCERN                      ☐ [ NONPROFIT ORGANIZATION

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I acknowledge the duty to file, in this application or patent, notification of any change in status resulting in loss of entitlement to small entity status prior to paying, or at the time of paying, the earliest of the issue fee or any maintenance fee due after the date which status as a small entity is no longer appropriate. (37 CFR 1.28(b))

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application, any patent issuing thereon, or any patent to which this verified statement is directed.

NAME OF PERSON SIGNING Dipl.-Ing. Rainer Kurtz  
TITLE OF PERSON OTHER THAN OWNER President  
ADDRESS OF PERSON SIGNING Gerhard Hauptmann Str.9, 97877 Wertheim

SIGNATURE  DATE 10.09.1999

63896.5



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RECORDATION DATE: 10/13/2000

REEL/FRAME: 011241/0034  
NUMBER OF PAGES: 3

BRIEF: CHANGE OF NAME (SEE DOCUMENT FOR DETAILS).

ASSIGNOR:

ERSA LOETTECHNIK GMBH

DOC DATE: 05/03/2000

ASSIGNEE:

ERSA GMBH

LEONHARD-KARL-STR. 24

D-97877 WERTHEIM, FED REP GERMANY

SERIAL NUMBER: 09394732

PATENT NUMBER:

FILING DATE: 09/13/1999

ISSUE DATE:

SERIAL NUMBER: 09545157

PATENT NUMBER:

FILING DATE: 04/07/2000

ISSUE DATE:

SERIAL NUMBER: 29124150

PATENT NUMBER:

FILING DATE: 05/31/2000

ISSUE DATE:

DOROTHY RILEY, PARALEGAL  
ASSIGNMENT DIVISION  
OFFICE OF PUBLIC RECORDS

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13-0410

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10. To the best of my knowledge and belief, the foregoing information is true and correct and any attached copy is a true copy of the original document.

John James McGlew  
Name of person signing

Req. No. 31,903

Signature

October 13, 2000  
Date

Total number of pages comprising cover sheet,  
attachments, and documents 3

JJM:jms

Enclosures:     - Assignment Document  
                  - Check for recording fee of \$120.00

SCARBOROUGH STATION  
SCARBOROUGH, NEW YORK 10510  
DATED: October 13, 2000

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McGLEW AND TUTTLE, P.C., SCARBOROUGH STATION,  
SCARBOROUGH, NEW YORK 10510-0827

By:                       
63896.8

Date: October 13, 2000



ATTORNEY DOCKET NO: 63896

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant : CANNON  
Serial No : 09/394,732  
Filed : September 13, 1999  
For : APPARATUS AND METHOD...  
Art Unit : 2877  
Examiner : Pham, H.  
Dated : December 7, 2000

Hon. Commissioner of Patents  
and Trademarks  
Washington, D.C. 20231

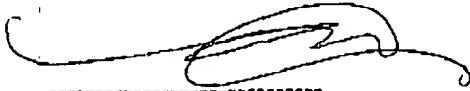
DECLARATION UNDER 37 C.F.R. §1.132

I, Mark Cannon, hereby state as follows:

1. I am the inventor of the invention disclosed and claimed in the above referenced U.S. patent application.
2. Since the introduction of the area array package or ball grid array (BGA) over 15 years ago, the single largest problem has been with the ability to control the process due to the fact that visual inspection after soldering was considered impossible. This standpoint has been documented by all international specifications including NASA, Military Specification 2000, and IPC. Additionally, in every publication written by world renown industry experts, visual inspection of the BGA after soldering is not possible but is needed based on the limitations of x-ray technology which is the state of the art. The high cost of x-ray inspection equipment has also been repeatedly noted in all international publications as a limiting and negative factor. The need for low cost, visual inspection for BGA components has been long felt and well documented. This is supported for example by the article by Phil Zarrow from the December 19, 1999 Circuits Assembly publication. Mr. Zarrow notes that the emergence of array packages has raised the question of how to inspect the inner connections. Mr. Zarrow notes that x-ray equipment as well as laminography equipment was initially used. Mr. Zarrow noted that x-ray equipment did not provide sufficient information with regard to defects like opens and voids.
3. Upon my invention being fully developed and sold, the reaction by the consuming public has been very good. The invention has met with extraordinary commercial success. As noted in Mr. Phil Zarrow's article, with the device of my invention, it is now possible to actually see under the array packages to visually examine the soldered joints and see many other critical things. The commercial success of the product has been substantial. This is evidenced by the attached list indicating various manufacturers that have bought or are using the device of the invention.

The success is also demonstrated by the numerous international innovation awards given to the invention and product according to the invention as detailed in the attached press release. To my knowledge, no single product has won all of these awards. This is an indication that there has been a long felt need and that the invention is indeed nonobvious. The device has only been on sale for a short time. The tremendous numbers of units placed and the various different companies that use the device of the invention highlights the acceptance of the product. The commercial success also highlights that the product has satisfied the long felt need with regard to solder joint inspection. The commercial success indicates the non-obvious aspect of the invention.

4. I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.



Mark Cannon

63896.14

Enc.: Article by Phil Zarrow from the December 19, 1999 Circuits Assembly publication

International ERSASCOPE Users List

Press release indicating awards for product of the invention

052340 052341  
052340 052341  
052340 052341

application is not disclosed in the prior United States application in the manner provided by the first paragraph of Title 35, United States Code 112, I acknowledge the duty to disclose material information as defined in Title 37, Code of Federal Regulations, 1.56 which occurred between the filing date of the prior application and the national or PCT international filing date of this application:

(Application Serial No)

(Filing Date)

(Patented, Pending, Abandoned)

(Application Serial No)

(Filing Date)

(Patented, Pending, Abandoned)

I hereby appoint the following attorney(s) and/or agent(s) to prosecute this application and to transact all business in the Patent and Trademark Office connected therewith: **John J. McGlew, Reg. 17,722; and/or John James McGlew, Reg. 31,903; and/or Hilda S. McGlew Reg. 30,295; and/or Theobald Dengler, Reg. 34,575; and/or Kristina M. Grasso Reg. 39,205.**

Address all calls to: John James McGlew at telephone no. (914) 941-5600

Address all correspondence to:

**McGLEW AND TUTTLE, P.C.  
SCARBOROUGH STATION  
SCARBOROUGH, NEW YORK 10510-0827**

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

Full name of sole or first inventor Mark CANNON

→Inventor's signature 

→Date 8th of September 1999

Residence: Ebinger Str. 26c, D-76139 Karlsruhe, GERMANY

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